Population Characteristics of *Dendrolims Superans* in Daxing'an Mountains

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Abstract　*Dendrolims superans* produced one generation every two years. Large larvae and small larvae exist at the same time. It broke out in Daxiang'an Mountains in 1990, and seriously destroyed growth of *Larix gmelini* Rupr. In order to control *D. superans*, the population properties of *D. superans* were studied from 1991 to 1992, including sex ratio, age distribution, pattern etc.. The sex ratio of *D. superans* population is ♀ : ♂ =1.06:1. The larvae age distribution indicates that larvae over 5 instar is less than younger larvae under 4 instar in Yongqing forest farm, but the younger larvae under 4 instar is more than larvae over 5 instar in Hanjiayuanzi Forest Farm. The population of *D. superans* in Yongqing Farm has been declining, and increasing in Hanjiayuanzi. Pupae and eggs are mainly distributed in middle and lower crowns layer of trees, respectively account for 66% and 59.5% of total individuals. The pupae in higher crown layer is lightly regular distribution, and clumping distribution middle and lower crowns layer of trees. The eggs in higher crown is light clumping distribution , and random in middle and low crown of tree.

Key words: *Dendrolims superans*, Daxing'an Mountains, Population Characteristics, Special pattern

Methods

Collection of data

Five hundred heads of *D. supernal* were collected in the forest, or around forest area during the peak of appearance from 1991 to 1992. The number of female and male adults were recorded.

Two standard plots were chosen in Yongqing and Hanjiayuanzi Forest Farm of Shibazhang Forest Bureau respectively in Autumn of 1992. 20 trees of larch were picked up randomly in the plots. The number of every instar of larvae was recorded respectively.

In 1991, during pupae period (spring) and egg period (summer), in the larch forest along the 44 branch 1km, 46 branch 7 km, 51 branch 10 km land, 51 branch 2 km of 305 country road and the Three Towers 18 km land, a small plot with 20 trees was chosen randomly. The number of pupae and eggs of every tree was recorded. At the same time, a plot with a area of 40 m × 30m along 44 branch 1 km land was picked up in which 5 small plots with 20 trees were chosen randomly every time. The number of pupae and eggs in high, middle and low crowns layer on every tree was recorded.

Data analysis

Aggregation index of David & Moore

$I = S^2 / \bar{X} - 1$

I=0　random distribution

$I < 0$　even distribution

$I > 0$　clumping distribution

Regression of Iwao of $\bar{X}^* - \bar{X}$

$\bar{X}^* = \alpha + \beta \bar{X}$.　α indicates the basic factor of distribution

α =0　the basic factor is individual

$\alpha > 0$ the basic factor is individual group and individuals attract each other

$\alpha < 0$ individuals repel one another

$\beta = 1$ random distribution

$\beta < 1$ even distribution

$\beta > 1$ clumping distribution

Iwao indicated:

$\alpha = 0$, $\beta = 1$ or $\alpha > 0$, $\beta < 1$ random distribution

$\alpha = 0$, $\beta > 1$ or $\alpha < 0$, $\beta > 1$ clumping distribution

Taylor index

$\lg s^2 = \lg a + b \lg \bar{X}$

$\lg a = 0$ $b = 1$ random distribution

$\lg a > 0$ $b = 1$ clumping distribution

$\lg a > 0$ $b > 1$ clumping distribution

$\lg a < 0$ $b < 1$ the more intensive population density is, the more even the distribution is.

Results and Analysis

Sex ratio

According to the measure during 1991~1992, the sex ratio of *D. superans* in Shibazhang Forestry Bureau is ♀ : ♂ =1.06:1, is about 1 : 1, and female is a little more than male. The results indicate if the environment is preferable, *D. superans* tends to break out.

Age distribution

D. superans produced one generation every 2 years in Daxing'an Mountains. The large and small larvae exist at the same time. The larvae are divided into two groups. One is small larvae of this year that is less than 4 instar, and the other is large one of last year that are more than 5 instar (See Table 1).

According to Table 1, in Yongqing Forestry Farm, the young larvae instar of *D. superans* shows middle, low instar, especially the percentage of larvae under 4 instar, is less than larvae over 5 instar. The results show the population of *D. superans* is declining. In Hanjiayuanzi, the percentage of young larvae under 4 instar is larger than that of Hanjiayuanzi, which indicates the population of *D. superans* is increasing.

The analysis of age population is helpful to forecast the trend of population which is the basis of integrated management of *D. superans*. The population intensity in two forests is less than control threshold (20 larvae/tree). But the population of *D. superans* in Hanjiayuanzi is increasing, so it should be monitored. If it is necessary, the population should be controlled with effective control methods. In Yongqing forest farm, the population is declining, natural control and biological control was used to maintain the low population density and preserve the diversity of ecosystem.

Table 1. The Age distribution of *D. superans* (%)

Location	Instar period of larvae							
	1	2	3	4	5	6	7	8
Yongqing Forest Farm	0.0	0.0	2.3	4.6	2.3	50	29.5	11.4
Hanjiayuanzi	7.6	23.7	30.5	24.4	3.1	8.4	2.3	0.0

Spatial pattern of pupae and eggs The spatial pattern of population of *D. superans* is an important trait of population. It reflects the relation between population and individuals, and also reflects existing pattern of individuals. That is to say, it reflects the individuals exist whether in the form of individual or in the form of individual group. It is the theoretical basis of population regulation of *D. superans*.

Horizontal pattern of population The data about horizontal distribution of larvae, pupae and eggs in different forest collected in 1991 are listed in Table 2 and Table 3.

The aggregation index calculated from the data in Table 2 and Table 3 are listed in Table 4.

According to Table 4:

$I = 0.85 > 0$ clumping distribution (pupae) $\alpha = 0.46 > 0$ the individuals among pupae attract one another and the basic pattern is individual group and $\beta = 1.16 > 1$ clumping distribution (pupae)

$\lg a = 0.175 > 0$ and $b = 1.179 > 1$ clumping distribution as for eggs:

$I = 0.04 \rightarrow 0$ random distribution $\alpha = -0.056 \rightarrow 0$ and $\beta = 1.037 \rightarrow 1$ random distribution $\lg a = -0.008 \rightarrow 0$, $b = 1.03 \rightarrow 1$ random distribution

Table 2. The Horizontal distribution of pupae (1991)

Location	Number of investigated trees	$\bar{X}$	$\lg \bar{X}$	s^2	$\lg s^2$	$\bar{X}$
Three Tower 18km	20	2.5	0.398	4.05	0.61	3.12
46 branch 7 km	20	3.4	0.531	7.14	0.85	4.5
44 branch 1 km	20	1.7	0.23	2.21	0.34	2.0
51 branch 10 km	20	2.4	0.38	4.24	0.63	3.17
51 branch 2 km	20	1.4	0.15	2.84	0.45	2.43

The aggregation index mentioned above can express the actual population distribution, so any index above

can describe the horizontal pattern of population.

The vertical pattern of population

The vertical distribution of population of different developing stage is different. The pattern shows the inherent trait of population, and is an adaptive style of population in order to develop themselves. The vertical pattern is showed in Table 5 and Table 6.

Table 3. The Horizontal distribution of eggs (1991)

Location	Number of investigated trees	$\bar{X}$	$\lg \bar{X}$	s^2	$\lg s^2$	$\bar{X}$
Three Tower 18 km	20	0.65	-0.187	0.628	-0.202	0.61
46 branch 7 km	20	1.2	0.079	1.16	0.065	1.17
44 branch 1 km	20	0.85	-0.071	0.828	-0.085	0.818
51 branch 10 km	20	0.95	-0.022	0.918	-0.023	0.948
51 branch 2 km	20	1.05	0.021	1.048	0.021	1.04

Table 4. The Aggregation index of eggs and pupae

Developing stage	Number of investigated trees	Average density	Variance	David & Moore index	$\bar{X}^* - \bar{X}$ regression			Taylor	
	N	$\bar{X}$	S^2	I	α	β	γ	$\lg a$	b
Pupae	100	2.1	3.89	0.85	0.406	1.16	0.95	0.175	1.19
Eggs	100	0.94	0.978	0.04	-0.056	1.04	0.99	-0.008	1.03

Table 5. The vertical pattern of pupae (44 branch 1 km, 1991)

Crown location	Density (pupae/ tree)													Percentage of tree with pupae (%)	Percentage of pupae (%)	$\bar{X}$	s^2	I
	0	1	2	3	4	5	6	7	8	9	10	11	12					
Higher	89	11	0	0	0	0	0	0	0	0	0	0	0	11	7.2	0.11	0.098	-0.11
Middle	63	9	13	8	3	1	0	1	1	0	1	0	0	37	66	1.01	3.17	2.14
Lower	77	11	7	3	2	0	0	0	0	0	0	0	0	23	27.5	0.42	0.804	0.914
Whole tree	49	15	13	11	4	2	0	0	0	1	2	0	1	51		1.53	5.429	

Table 6. The vertical pattern of eggs(44 branch 1 km, 1991)

Crown location	Density (pupae/1 tree)						Percentage of tree with pupae (%)	Percentage of pupae (%)	$\bar{X}$	s^2	I
	0	1	2	3	4	5					
Higher	89	9	1	0	0	0	11	12.4	0.11	0.12	0.073
Middle	78	19	3	0	0	0	22	28.1	0.25	0.248	-0.008
Lower	59	31	8	2	0	0	41	59.5	0.53	0.529	-0.002
Whole tree	43	35	15	5	1	1	57		0.89	1.02	0.14

According to Table 5 and Table 6, the results show that pupae that concentrate in the middle of crown layer take up 66%, and eggs that concentrate in lower crown layer take up 59.5%, which indicates different developing stage tend to separate in order to avoid inter species competition. Pupae and eggs in higher crown layer are less (about 10%), they mainly concentrate in middle and lower crown of tree. When we investigate pupae and eggs, we can record them in middle and lower crown layer.

The horizontal pattern of pupae and eggs that gather in different crown locations is different. The pupae in higher crown layer appear even distribution, they appear clumping distribution in middle and lower crown layer. Aggregation intensity of pupae in middle crown is more intensive than that in lower crown. The eggs in higher crown appear clumping distribution, and they appear random distribution in middle and lower crown

layer.

Conclusions

The sex ration of *D. superans* in Shibazhang Forest Bureau is ♀ : ♂ =1.06 : 1. In Yongqing Forestry Farm, the percentage of young larvae over 5 instar, is less than that of older larvae, which shows the population of *D. superans* is declining. In Hanjiayuanzi, the percentage of young larvae is contrary to that in Yongqi, which indicates the population of *D. superans* is increasing.

The horizontal pattern of pupae and eggs is clumping and random distribution respectively. The pupae in middle crown layer take up 66%, the eggs in lower crown layer take up 59.5%. The pupae in higher crown appear even distribution, they appear clumping distribution in middle and lower crown. The aggregation intensity of pupae in middle crown is more intensive. The eggs in higher crown appear clumping distribution, and they appear random distribution in middle and lower crown.

References

1. 刘宽余, 孟庆繁等. 1994. 大兴安岭落叶松毛虫生物学特性的研究. 东北林业大学学报. 22(2): 1~5

2. 孟庆繁, 刘宽余等. 1995. 兴安岭落叶松林龄与耐害性的关系研究. 东北林业大学学报. 23 (5): 46~50

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